Vibrating batteries for GSM phones

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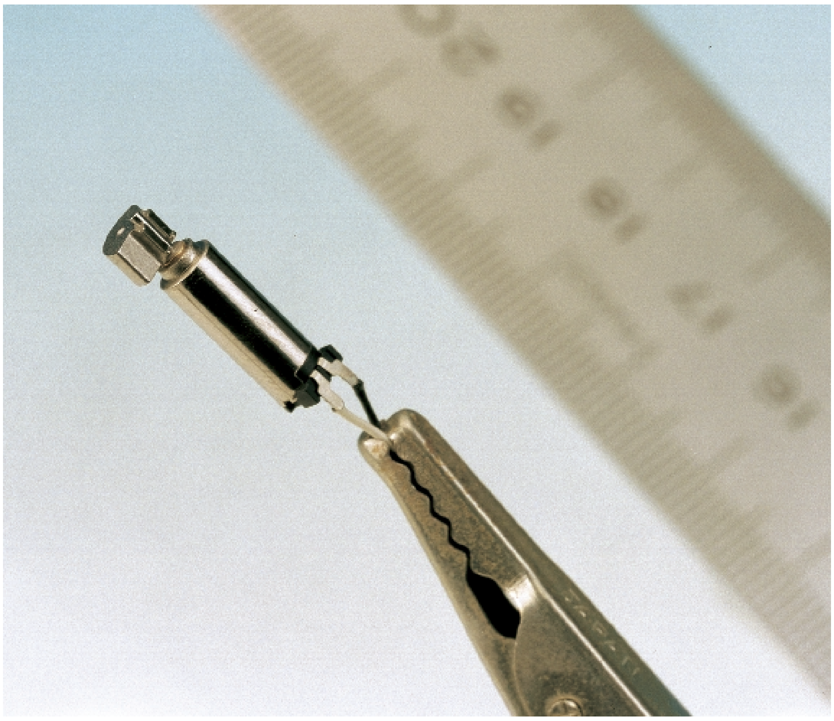

Figure 1. The secret of the vibration alarm revealed: a tiny DC motor with an eccentric weight on its shaft.

It's often the small, everyday things that turn out to have interesting features when you examine them more closely. In any case, here you can learn how vibration alarms and other mobile phone call annunciators work, and how GSM phone batteries are constructed.

Maybe you've already wondered how a vibration alarm in a GSM phone actually works. Obviously, it must be small, but what else can you say about it? Want causes it to vibrate? An oscillating coil perhaps, or an oscillating armature? Or is it perhaps a miniature motor with an eccentric weight?

Well, did you guess right? **Figure 1** shows the secret of the vibrating battery: a tiny DC motor with a small weight attached to its shaft so that it is unbalanced when it rotates, and thus vibrates. The example in the photograph was kindly made available to us by Panasonic. The diameter of this mini-motor is only 3.8 mm, and its overall length (including the shaft and eccentric weight) is around 16 mm. The tiny weight is 3 mm long, and it has an outside diameter of 3 mm and an inside diameter of 1 mm. It rotates at approximately 10,000 rpm in order to get your attention. At its rated supply voltage of 1.3 V (working range 0.6 V to 1.6 V), the motor draws at least 65 mA. If you visit the web site of Global Sources (*www.globalsources.com*) and enter 'vibration motors' as the search string, you will see that most Japanese and Chinese manufacturers offer a large assortment of vibration motors of all types.

The photograph in **Figure 2** shows how such a motor (in this case a somewhat larger model) is integrated into a GSM battery package. We simply chiselled open up a standard vibrating battery for a Nokia 6110 GSM phone, and *voilà:* you can't help noticing the vibration motor, which takes up a relatively large amount of space. Even so, there's no overcrowding, since a Sony lithium-ion battery (3.6 V/1000 mAh) has been used here. This is only half as big as the standard set of three NiMH penlight cells normally used with the 6110, which pretty well fill the enclosure of the battery pack. **Figure 3** shows what this type of battery pack looks like when fitted with NiMH cells. The cell block, which consists of five cells for a voltage of 6 V (for a Nokia 3110, for example), is glued into the upper shell of the battery enclosure using a special heat-resistant adhesive. Prior to this, the individual cells are glued to each other and interconnected using welded-on metal

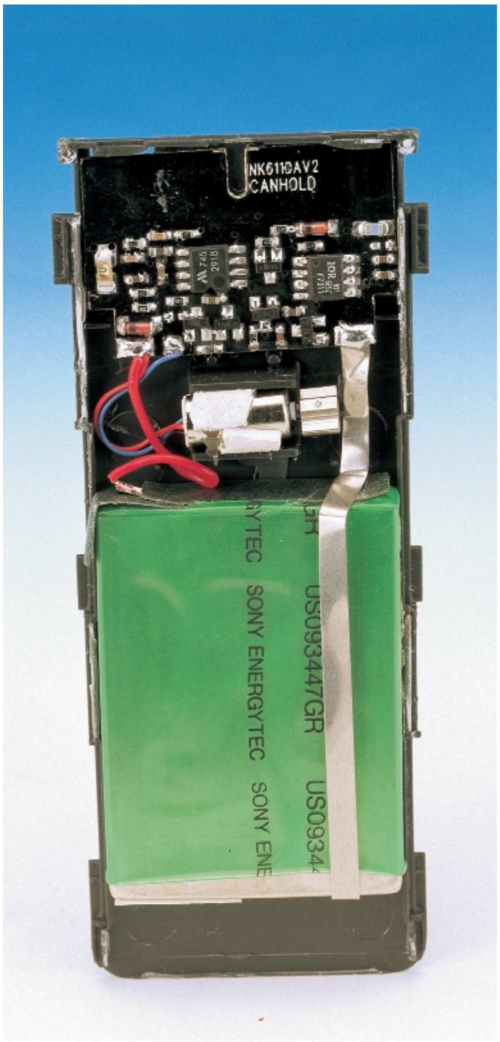

Figure 2. What's inside a standard commercial vibration battery. The vibration motor is mounted between the SMD circuit board containing the charge control circuit and the actual battery, which is a 3.6-V, 1-Ah lithium-ion cell.

strips. A polyswitch is also welded to the assembly to provide short-circuit protection, as well as a thermal cutout that protects against overcharging. In addition, a flexible printed circuit that houses a temperature sensor for monitoring the battery temperature is welded to the cell block. Incidentally, batteries for laptop computers that contain NiMH cells are also constructed in this manner.

If you compare **Figure 2** with this, you can see that the amount of supplementary circuitry needed for a lithium-ion battery is even greater. Here you can see a densely populated little SMD circuit board that holds the charge control circuit and also provides connections for the vibration motor.

The vibration motor is normally driven by the GSM phone via an electrical contact on the battery pack when the acoustic alarm is switched off.

Clearly, a different solution must be used with separate call annunciators, which can be inexpensively purchased as accessories for GSM phones. These have both an optical indicator (LED) and a vibration alarm. In this case there seems to be a mysterious wireless link between the GSM phone and the annunciator. The mystery is deepened by the fact that simple annunciators in the form of a ballpoint pen with a blinking light are available for a only few pounds. This suggests that the construction of the sensor circuit must be very simple and inexpensive. And indeed, such annunciators contain only an simple broadband field strength detector, consisting of an aerial, a resonant circuit and a Schottky diode, that drives the LED or vibration motor via a simple bit of circuitry whenever the GSM phone transmits a signal. The annunciator gives the impression that it indicates that the phone is ringing. However, this is essentially due to the fact that when an incoming call is detected, the GSM phone diligently sends data bursts to the nearest base station during the 'ringing' interval in order to request a free channel from the network and set up the connection (Channel Request and SDCCH). Since the annunciator only detects that the GSM phone is transmitting, it also reacts when the phone is not ringing, if the phone transmits to the base station for some other reason. This can for example happen during the sign-on sequence after the phone is switched on, when the phone is searching for the network and when the location changes (Location Update). Since these simple annunciators have relative non-selective signal detectors, they can also respond to other transmitters and HF noise signals, such as are radiated in the vicinity of fluorescent lamps.

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Figure 3. Construction of a battery pack with NiMH cells.